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Grass Seed Cropping Systems for a Sustainable Agriculture
Washington State Department of Ecology
Idaho Department of Environmental Quality/North Idaho Farmers Association
Washington Turfgrass Seed Commission
Coeur d'Alene Tribe
Environmental Protection Agency (Idaho)

Title: Quantifying Post-harvest Emissions from Grass Field Burning

Principal Investigators:

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(0.05 FTE).

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Cooperators:

Missoula Fire Sciences Laboratory, USDA Forest Service, Missoula, MT. Will provide instrumentation and emissions collection.

DataChem Laboratories, Salt Lake City, UT. Will perform chemical analysis.

C. Claiborn, Assoc. Professor, CEE, WSU, will participate in emissions monitoring as able.

Washington Turfgrass Seed Commission. Growers will provide research sites and provide field assistance as necessary.

North Idaho Farmers Association. Growers will provide research sites and provide field assistance as necessary.

Statement of Problem:

The grass seed industry of eastern Washington, in April and August 1997, proposed to the Washington Agriculture Burning and Research Task Force (WABRTF) a study, similar to the current proposal, designed to evaluate the emissions produced from the burning of post-harvest residue from Kentucky bluegrass seed fields. The Grass Seed Cropping Systems for a Sustainable Agriculture (GSCSSA), a USDA special grant, also allocated $90,000 (grants of $60,000 and $30,000) to the project. This indicates strong support for the project from the seed industry, GSCSSA, and the WABRTF. Unfortunately, the level of funding achieved was not sufficient to finance the project (estimated $150,00 to $200,000 with the original subcontractor, Battelle PNNL). There also were contractual difficulties with the initial subcontractor. Consequently, the project was initiated, but has yet to be completed.

Recently there has been a renewed effort to complete the project. The WABRTF (2 June 1999) reiterated the need for emission data (primarily from cereal burning) and subsequently asked WSU to consider becoming involved in cereal emissions research. At several follow up meeting in September and October, the Cereal Grain Emissions Task Force (subcommittee of the WABRTF), composed of air quality scientists, cereal and grass growers, WSU scientists and extension personnel, and WDOE personnel, identified research priorities for cereal. The consensus of the group was that there are very definable problems on which WSU and Air Sciences Inc. could collectively conduct field burning emissions research in a timely manner, both on cereal residue and grass seed post-harvest residue.

The Washington Turfgrass Seed Commission (WTSC) strongly supports the current proposal and stated in a letter to the GSCSSA Administrative Committee (January 28, 2000) that "our [i.e., this proposal] project will parallel the procedures for emissions data collection and analysis established by the WDOE and Washington Association of Wheat Growers (WAWG) in order to create a reliable baseline for emissions from our industries agricultural burning. Our ability to participate in these studies brings the cost for both industries down and begins to establish a very important body of information for agriculture. Although Washington currently allows no grass seed field burning, Idaho will greatly benefit from these studies (Lee Morris, WTSC, 2000)." Growers and regulatory agencies realize agricultural burning will face a high level of scrutiny and emissions data will be essential for rational decision and policy making.

This proposal will evaluate emissions generated from grass seed production fields with fuel reductions in comparison to those burned without fuel reductions in an effort to reduce emissions. The information obtained from this study will help establish appropriate burning practices needed to significantly reduce emissions, contribute to the scientific data base on agricultural burning emissions, as well as provided data to direct future research.

Justification:

Fire has long been used as a management tool in grass seed production (Burton, 1944; Conklin, 1976; Chilcote et al., 1978; Hardison, 1980; Johnston et al., 1996; Kamm and Montgomery, 1990; Mazzola et al., 1997; Schirman, 1997). However, increasing concerns over the health impact of emissions from open-field burning have pointed to the need for information on grass fire emissions. Although some data are currently available that identify and quantify the various chemical components of grassfire emissions in the Pacific northwest (Adams, 1976; Boubel et al., 1969; Jenkins, et al., 1996), and biomass burning (Crutzen and Andreae, 1990; Kuhlbusch et al., 1991), little research has been performed with residue reduction-flaming (bale and burn) systems. Because mechanical residue removal is an option growers can use to reduce the fuel load on grass fields, emissions from fields where residue has been removed and fields with typical post-harvest residue fuel loads will be studied. Although past WSU research, in a never completed project, indicated increased emissions with residue removal and open-field burning (Adams, 1976), current WSU research with residue reduction (baling) followed by diesel or propane flaming indicates the possibility of reduced emissions and reduced smoldering while maintaining good seed yield (Felgenhauer, personal communication, 1999; Johnston, 1997). Characterization of particulate emissions from the bale and flame/burn system are needed since a cooler burn, compared to open-field burning, is possible. Ultimately, smoke reduction and management should be based on emissions rather than number of acres burned. However,

insufficient research on grassy fuels has been conducted to characterize emissions to the degree necessary for the development of BMPs.

Objective:

Quantify, under field conditions at dryland and irrigated sites, with and without residue removal, amount of selected emissions generated by Kentucky bluegrass seed production post-harvest residue field burning.

Procedures (Project Scope of Work):

Task 1: Experimental Plan. Washington State University (WSU) will prepare the proposal and a comprehensive experimental monitoring plan (Task list). Air Sciences Inc. will review the experimental plan (Air Sciences labor 4 hour) .

Task 2: Unit Identification and Treatments. Washington State University will identify three, 20- to 50-acre minimum (depending on size of burn units) study sites in eastern Washington (Site 1, Columbia Basin) and northern Idaho (Site 2, dryland site in north Idaho and Site 3, irrigated site in north Idaho) during late spring and early summer, 2001. Two alternative residue treatments will be evaluated at each site: no residue treatment ("full load"), and pre-burn baling ("reduced load"). Each treatment will consist of three separate 2- to 8-acre burn units (replications). A total of 18 burns will be conducted (3 sites, 2 residue loads, and 3 replications). Washington State University will select the burn units in consultation with Air Sciences Inc. (Air Sciences may, but will not be required to, make site visits for unit identification and can lend expertise via phone, email, etc.). WSU will be responsible for contacting the prospective host growers to obtain their consent.

Task 3: Unit Layout. Washington State University will be responsible for Task 3. WSU will stake the corners of each burn unit with wooden stakes. A firebreak will be constructed around each burn unit of a type and size adequate to stop the forward progress of fire under the most extreme conditions that are likely to occur at each site. The host grower will be responsible for constructing and maintain the firebreak, for igniting the fire under the conditions prescribed by the principle investigators, and for providing fire suppression equipment and personnel during the burn in order to respond in the event of an escaped fire. The grower(s) will be responsible for any and all costs related to establishing the firebreak around each burn unit and any costs incurred in the event of an escaped fire.

Task 4: Pre-burn Residue Loading. The pre-burn surface fuel loading within each burn unit will be characterized. The residue loading will be determined by destructive sampling at random locations within the burn units. Air Sciences Inc. will provide one technician with past residue sampling experience at the initial burn site (Site 1, Columbia Basin) to assist in performing pre-burn fuel sampling (on site labor 6 hours). Air Sciences will provide 3 cordless rechargeable grass clippers to aid in the pre-burn sampling. WSU will supply additional materials required to obtain pre-burn residue samples (Air Sciences and WSU will consult, via phone, etc., as to sampling technique

and materials required). WSU will provide 3 technicians to assist at initial site (Site 1) and will be responsible for performing the pre-burn fuel sampling at Sites 2 and 3. Following sampling, Washington State University will be responsible for handling the samples, laboratory analysis, and transmitting the pre-burn residue dry weight data electronically to Air Sciences Inc.

Task 5: Pre-burn Moisture Sampling. Immediately prior to the burn, the moisture content of the grass residue and the upper layer of soil will be characterized. Air Sciences Inc. will provide one technician with past residue and moisture sampling experience at the initial burn site (Site 1) to assist in performing sampling (on site labor 6 hours). WSU will provide 3 technicians to assist Air Sciences at Site 1 and will be responsible for performing the pre-burn moisture characterization at additional sites. Following sampling, Washington State University will be responsible for handling the samples, laboratory analysis, and transmitting the pre-burn residue moisture and soil moisture data electronically to Air Sciences Inc. If possible, these tasks will be performed in conjunction with those listed under Task 4, Pre-burn Residue Loading.

Task 6: Emissions Monitoring. Missoula Fire Science Laboratory will perform the emissions monitoring using the Missoula Fire Science Laboratory's Fire-Atmosphere Sampling System (FASS). FASS is a tower-based system that measures real-time emissions. The computer control system, battery, pumps and flow meter, manifolds, particulate matter filters (Teflon and glass), real time analyzers, and the three-part gas collection system (one part for each phase of the burn, i.e., flaming, transitional, and smoldering) are buried near the instrumentation towers. Two guyed instrument towers (two sub-samples per plot) holding the FASS equipment will be erected on each plot. Air Sciences Inc. will also provide one experienced field technician (Gary Wentz for 24 hour on site labor per site for a maximum of 72 hours for the three sites) for directing the emissions sampling, given the assistance of at least two experienced field technicians provided under a contract with the Missoula Fire Sciences Laboratory.

Air Sciences will provide a portable MET station for use in monitoring and recording the meteorological events during each of the burns at each of the sites. Mark Schaaf of Air Sciences Inc. will be on site (maximum of 48 hours) at Sites 1 and 2 only.

Task 6 also includes post-burn residue sampling of each of the 18 burn units. WSU will provide 3 technicians to assist Air Sciences in performing the post-burn residue sampling at Site 1 (Air Science will provide 1 technician for on site labor of 6 hours for post-burn sampling; technician total of 24 hours for Tasks 5 and 6). WSU will perform the post-burn residue sampling at Sites 2 and 3. Following sampling, Washington State University will be responsible for handling the samples, laboratory analysis, and transmitting the post-burn residue dry weight data electronically to Air Sciences Inc.

Task 7: Sample Analyses. The Missoula Fire Sciences Laboratory will be responsible for Task 7. Following the burn, analyze the filter and gas samples for the following constituents: PM_{10}, $PM_{2.5}$, CO, benzo(a)pyrene (BaP) [a PAH], and six additional BaP-equivalent carcinogens listed in WAC 173-460-050(4)(c), including benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indenol(1,2,3-cd)pyrene. PAHs need not be measured directly in the field; they will be

determined from laboratory analysis of the filter samples. The $PM_{2.5}$ samples collected on glass-fiber filters for total mass and speciated PAH mass will be analyzed at DataChem Laboratories (DCL) at Salt Lake City, UT. The DCL facility in Salt Lake City is the National Institute for Occupational Safety and Health contract laboratory for analytical chemistry services. The Missoula Fire Sciences Laboratory will be responsible for all gas and filter sample analysis and for providing the data to Air Sciences Inc.

Task 8: Burn Characteristics. WSU and Air Sciences will share the responsibility of documenting the characteristics of each experimental burn. Burn characteristics will include: date and time of burning, type of fire and ignition pattern, air temperature, relative humidity, and mid-flame wind speed. Flame length, flame depth, flame angle, flame height, fire line depth, and rate of fire spread will be estimated and recorded on each burn if the conditions permit. In addition, each burn may be videotaped in order to more fully document the evolution and characteristics of each burn. Videotaping may be omitted if deemed not warranted by WSU. If burns are videotaped, WSU will provided needed equipment. Air Sciences Inc. will be responsible for documenting the burn characteristics listed herein for Sites 1 and 2. WSU will be responsible for documenting the burn characteristics at Site 3. Air Sciences and WSU will perform these tasks in conjunction with those listed under Task 6, Emissions Monitoring.

Task 9: Calculations, Data Analysis, and Interpretation. Air Science will compute the residue consumption, pollutant-specific emission factors, and total pollutant-specific emissions according to standard calculating procedures. Air Sciences will be responsible for interpretation of emissions data. Air Sciences will not exceed 100 labor hours on this task, nor will Air Sciences be responsible for costs related to shipping or sharing of data.

Task 10: Report. The results will be documented in a technical report (e.g., Air Sciences Inc., Experimental design: cereal grain crop open-field burning emissions study [draft], Project 152-01, Sect. 6.6, January 2000). Washington State University and Air Sciences Inc. will share the responsibility for completing this task. Air Sciences will provide technical assistance in developing the report (maximum of 32 hours). Washington State University will assume primary responsibility for oral reports and presentations to grower groups, environmental agencies, and other stakeholders as warranted and residual project funding permits.

Study Output:

This research will identify, at a minimum, the following data and relationships:

1. Pre- and post-burn residue loading on the plots (tons per acre). These data will be used to compute the total residue consumption in each test burn.
2. Meteorological and residue moisture content at time of burn. These data will be used to document any variability of conditions during burns.
3. Combustion efficiency (i.e., the proportion of total carbon released as CO_2, the more efficient the burn, the higher the percentage of CO_2 released).
4. Emissions factors for each phase for each pollutant and treatment combination (pounds of pollutant per ton of residue consumed). Along with residue consumption, this is a key determinant of the total burn emissions.

5. The study will provide direction for future research in the field. Such studies might include effect of residue moisture, wind speed, etc.
6. The study will enhance development of BMPs and will provide university extension personnel and burn permitting agencies with pertinent scientific data on which to base decisions on field burning.
7. The study will make a significant contribution to the knowledge base of emissions from agricultural burning.

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Budget:

Source of funds		Distribution of funds			
		Air Sci.	MFSL	WSU	WSU Indirect**
GSCSSA	$60,000	$18,000	$17,000	($25,000)*	$0
GSCSSA	$30,000	$17,000		$13,000	$0
WDOE	$14,000		$12,880		$1,120
IDEQ/NIFA	$25,000		$20,920		$2,000?
WTSC	$5,000		$4,600		$400?
Cd'A Tribe	$5,000		$4,600		$400?
EPA (Idaho)	$12,000			$11,040	$960?
	$151,000	$35,000	$60,000	$49,040	$4,880?

*WSU has spent $25,000 during the past three years working on this project with Battelle PNNL, grower meetings, agency meetings, custom equipment design and construction for burning trials with Battelle PNNL, Air Sciences Inc., etc., thus these funds are essentially $0 (currently $550).

** GSCSSA (USDA) stipulates zero indirect cost. Indirect cost to WSU for administration of WDOE grass seed funds fixed by Washington State legislature at 8%. WSU indirect funds generated if other grantors participate at 8% as WDOE. Funds not allocated to WSU Indirect costs will be shifted to WSU research cost associated with project.

Time Line:

June 2001: Prepare proposal, identify tasks and scope of work, have signed contracts in place.

July: Contact growers and identify burn sites, retrofit FASS system for bluegrass emissions, assemble needed equipment and materials, prepare sites to burn, conduct burn at Columbia Basin site.

August: Assemble needed equipment and materials, prepare sites to burn, conduct burn at north Idaho dryland and irrigated sites, analysis for residue dry weights and moisture, soil moisture, etc.

September – November 2001: Analysis of samples (filters), residue dry weights and moisture, soil moisture, etc.

December: Calculations, data analysis, and interpretation of results.

January 2002: Report writing.

February: Final report completed.